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The disagreement between two climate scientists that will decide our future

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Getting to net zero emissions by mid-century is conventionally understood as humanity's best hope for keeping Earth's surface temperature (already 1.2°C above its pre-industrial level) from increasing well beyond 1.5°C – potentially reaching a point at which it could cause widespread societal breakdown.

At least one prominent climate scientist, however, disagrees.

James Hansen of Columbia University in the US published a paper with colleagues in November which claims temperatures are set to rise further and faster than the predictions of the Intergovernmental Panel on Climate Change (IPCC). In his view, the 1.5°C target is dead.

He also claims net zero is no longer sufficient to prevent warming of more than 2°C. To regain some control over Earth's rising temperature, Hansen supports accelerating the retirement of fossil fuels, greater cooperation between major polluters that accommodates the needs of the developing world and, controversially, intervening in Earth's "radiation balance" (the difference between incoming and outgoing light and heat) to cool the planet's surface.

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There would probably be wide support for the first two prescriptions. But Hansen's support for what amounts to the deliberate reduction of sunlight reaching Earth's surface has brought into the open an idea that makes many uncomfortable.

Michael Mann from the University of Pennsylvania in the US and another titan of climate science, spoke for many when he dismissed solar radiation management as "potentially very dangerous" and a "desperate action" motivated by the "fallacy … that large-scale warming will be substantially greater than current-generation models project".

Their positions are irreconcilable. So who is right – Hansen or Mann?

Earth's radiation balance

First, an explanation.

There are only two ways to reduce global warming. One is to increase the amount of heat radiated from Earth's surface that escapes to space. The other is to increase the amount of sunlight reflected back to space before it lands on something – whether a particle in the atmosphere or something on Earth's surface – and is converted to heat.

There are many ways to do both. Anything that reduces the amount of greenhouse gas in the atmosphere will let more heat escape to space (replacing fossil fuels with renewables, eating less meat and tilling the soil less for example). Anything that makes the planet brighter will reflect more sunlight to space (such as refreezing the Arctic, making clouds whiter or putting more reflective particles in the atmosphere).

A gas flare at an oil refinery.

Carbon emissions pad the heat-trapping blanket in the atmosphere. Ian Rutherford/Alamy Stock Photo

But the key difference between the two, in terms of their impact on global warming, is their response time. That is, the time it takes for a change in the factors that allow more heat to escape or sunlight to be reflected to appear as a change in Earth's surface temperature.

Intervening to speed up the loss of heat from Earth's surface cools the planet slowly, over decades and longer. Intervening to increase the sunlight Earth reflects back to space cools the planet more or less immediately.

The essence of the dispute between Mann and Hansen is whether reducing greenhouse gases, by a combination of reducing new emissions and permanently removing past emissions from the atmosphere, is now enough on its own to prevent warming from reaching levels that threaten economic and social stability.

Mann says it is. Hansen says that, while doing these things remains essential, it is no longer sufficient and we must also make Earth more reflective.

When will warming end?

Mann aligns with IPCC orthodoxy when he says that emissions reaching net zero will result, within a decade or two, in Earth's surface temperature stabilising at the level it has then reached.

In effect, there is no significant warming in the pipeline from past emissions. All future warming will be due to future emissions. This is the basis for the global policy imperative to get to net zero.

In his new paper, Hansen argues that if the atmospheric concentration of greenhouse gases remains close to its current level, the surface temperature will stabilise after several hundred years between 8°C and 10°C above the pre-industrial level.

Of this, at least 2°C will emerge by mid-century, and probably a further 3°C a century from now. A temperature increase of this magnitude would be catastrophic for life on Earth. Hansen adds that to avoid such an outcome, brightening Earth is now necessary to halt the warming in the pipeline from past emissions.

Crevices in an ice sheet.

Bright surfaces, like ice sheets, reflect light to space. Tobetv/Shutterstock

But at the same time, we must also largely eliminate emissions if we are to stop recreating this problem in the future.

Still getting hotter…

We are scientists who study the feasibility and effectiveness of alternative responses to climate change, addressing both the engineering and political realities of enabling change at the scale and speed necessary.

We find Mann's rebuttal of Hansen's claims unconvincing. Crucially, Mann does not engage directly with Hansen's analysis of new data covering the last 65 million years.

Hansen explains how the models used by IPCC scientists to assess future climate scenarios have significantly underestimated the warming effect of increased greenhouse gas emissions, the cooling effect of aerosols and how long the climate takes to respond to these changes.

Besides greenhouse gases, humanity also emits aerosols. These are tiny particles comprising a wide range of chemicals. Some, such as the sulphur dioxide emitted when coal and oil are burned, offset the warming from greenhouse gases by reflecting sunlight back to space.

Others, such as soot, have the opposite effect and add to warming. The cooling aerosols dominate by a large margin.

Hansen projects that in coming months, lower levels of aerosol pollution from shipping will cause warming of as much as 0.5°C more than IPCC models have predicted. This will take global warming close to 2°C as early as next year, although it is likely then to fall slightly as the present El Niño wanes.

Underpinning Hansen's argument is his conviction that the climate is more sensitive to greenhouse gases than previously reported. The IPCC estimates that doubling atmospheric CO_2 raises Earth's temperature by 3°C. Hansen calculates it to be 4.8°C.

This, and the much longer climate response time that Hansen calculates from the historical record, would have a significant impact on climate model projections.

Time for reflection

The differences between Mann and Hansen are significant for the global response to climate change.

Mann says that allowing emissions to reach net zero by mid-century is sufficient, while Hansen maintains that on its own it would be disastrous and that steps must now be taken in addition to brighten the planet.

Brightening Earth could also reverse the reductions in reflectivity already caused by climate change. Data indicates that from 1998 to 2017, Earth dimmed by about 0.5 watts per square metre, largely due to the loss of ice.

Given what's at stake, we hope Mann and Hansen resolve these differences quickly to help the public and policymakers understand what it will take to minimise the likelihood of imminent massive and widespread ecosystem destruction and its disastrous effects on humanity.

While 1.5°C may be dead, there may still be time to prevent cascading system failures. But not if we continue to squabble over the nature and extent of the risks.

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